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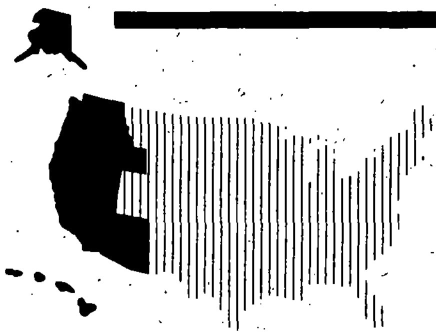

Remedial Activities at Selected Uncontrolled Hazardous Waste Sites in the Zone of Regions IX and X

Environmental Protection Agency
Contract No. 68-W9-0031

CH2M HILL

147833

QUALITY ASSURANCE PROJECT PLAN
Bunker Hill Mine Water Management

EPA CONTRACT NO. 68-W9-0031
WORK ASSIGNMENT NO. 31-84-105G
CH2M HILL PROJECT NO. 148562.05.02

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DRAFT

Remedial Planning Activities

ARCSWEST

Contract No. 68-W9-0031

Quality Assurance Project Plan

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Contents

SECTION 1

Introduction

U.S. Environmental Protection Agency (EPA) policy requires that all field sampling and laboratory work associated with CERCLA sites be centrally managed under a quality assurance (QA) program. This requirement applies to all environmental monitoring and measurement efforts mandated or supported by EPA.

This QA Project Plan (QAPP) presents the policies, organizations, objectives, and functional activities associated with the remedial activities at Bunker Hill Mine located in Kellogg, Idaho, for mine water management.

This QAPP follows the EPA guidelines contained in EPA QA/G-5 (1998). Thus, the following section headings correlate with the subtitles in EPA guidelines.

SECTION 2

Project Management/Data Quality Objective

2.1 Project/Task Organization (A4)

This project is being conducted by CH2M HILL at EPA's request under EPA Contract No. 68-W9-0031 and Work Assignment No. 31-84-105G. This work is described in the *Bunker Hill Mine Water Management Work Plan* (CH2M HILL, August 14, 1998).

This work assignment issued under ARCSWEST has an individual Site Manager (SM) who works directly with the EPA Work Assignment Manager (WAM) to accomplish the work assignment. The SM will control the financial, schedule, and technical status of the work assignment. The key people involved in interfacing with the SM are the WAM, Quality Assurance Manager (QAM), Review Team Leader (RTL), and individual task managers for field sampling, sample and data management, and data analysis/reporting.

The primary responsibility for project quality rests with the SM, independent quality control is provided by the QAM and RTL. The QAM and RTL review project planning documents, data handling and evaluation, and reporting documents.

The Sampling Team will implement the QAPP/FSP/HSP. The Site Safety Coordinator is responsible for adherence to the HSP and field documentation procedures. The field effort is directed by the Sampling Team Leader (STL).

Where quality assurance problems or deficiencies requiring special actions are uncovered, the SM, RTL, and QAM will identify the appropriate corrective action to be initiated by the SM.

A summary of quality assurance responsibilities and the quality assurance organization for the collection and analysis of samples are provided in Figure 2-1. Phone numbers for project team members are provided in the Field Sampling Plan (FSP).

2.2 Problem Definition/Background (A5)

The Bunker Hill Mine is located in Kellogg, Idaho, and consists of over 150 miles of passageways that extend to depths of over two thousand feet below sea level. The lower two-thirds of the mine are currently flooded. Water that infiltrates into the workings reacts with pyrite deposits in the ore and oxygen to produce acid water with high concentrations of metals, including lead, cadmium, and zinc. The two primary sources of water to the mine are groundwater that infiltrates into the sides and from the lower workings and surface water that infiltrates from above through mined drifts, raises, and stopes in the upper workings. The purpose of the Bunker Hill Mine Water Management project is to develop a cost-effective long-term management system for the Bunker Hill Mine acid mine drainage (AMD). The approach of the project is to develop a presumptive remedy based on an initial evaluation of the alternatives, and revise and fine tune the remedy throughout the project.

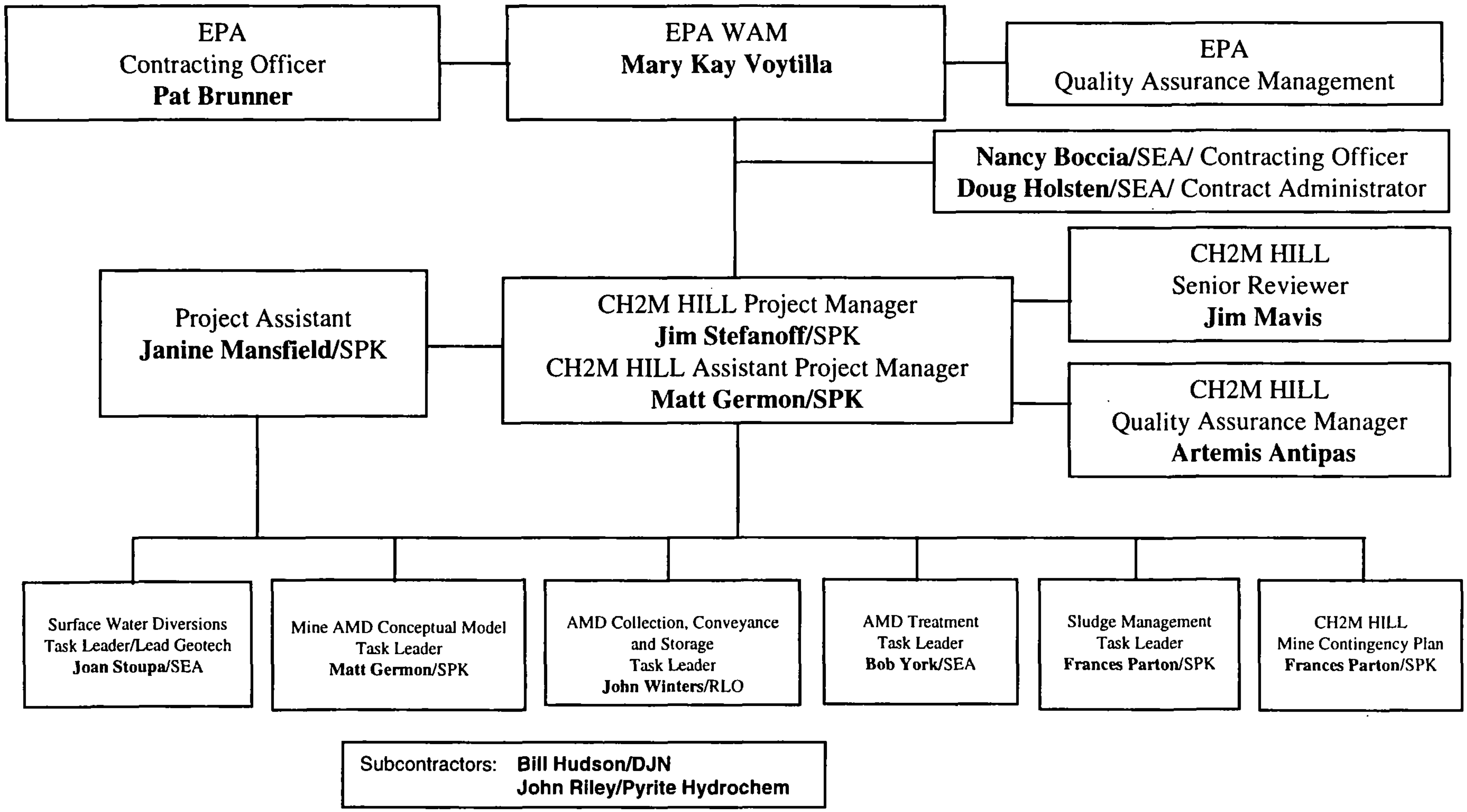

Figure 2-1
Bunker Hill Mine Water Management
Organizational Chart

The four main components of the presumptive remedy are AMD generation mitigation; AMD collection, conveyance, and storage; AMD treatment; and sludge disposal. Each of these aspects is discussed in more detail below. Additional information is provided in the tables presented in Section 2.3.

The objective of the AMD generation mitigation component is to evaluate the reduction in AMD that could be achieved by diverting surface water that is known to infiltrate into the upper workings of the mine, and by other methods. Work will include a conceptual design and evaluation of surface water diversions on various forks of Milo Creek. It also includes revising and updating the conceptual model of hydraulic and metals loading from the upper workings.

The AMD collection, conveyance, and storage component will be evaluated by using the revised conceptual model to identify key conveyance corridors, evaluate alternate collection methods, evaluate existing piping to the central treatment plant (CTP), and evaluate storage within the mine and in lined reservoirs.

The AMD treatment component will include a review of current CTP performance, and an evaluation of best available treatment (BAT) to meet new discharge requirements for the South Fork of the Couer D'Alene River. A conceptual design for a CTP upgrade will also be presented.

The disposal of sludge produced during treatment will be evaluated to determine the most cost effective and feasible disposal method. Work will include the identification and evaluation of in-mine disposal locations and capacities, landfill disposal, and disposal to sludge drying ponds.

2.3 Project/Task Description (A6)

Tables 2-1a through 2-1d present tasks to be conducted to develop the presumptive remedy. These tables describe the tasks and activities, the purpose and goal of each, and the expected end product.

2.3.1 Data Needs and Uses

The following steps outline the data needs and uses associated with developing the presumptive remedy and with refining the conceptual model. The steps are presented per EPA data quality objectives process guidance (EPA QA/G-4, September 1994). Data needs and uses are summarized in Table 2-2.

Step 1: State the Problem

Problem statement has been described above in Section 2.2 and Table 2-1. Specifically, the hydraulic and metals loading from different areas of the Bunker Hill Mine needs to be understood for development of the presumptive remedy and to revise the conceptual mine model.

Step 2: Identify the Decision

Decision processes for the tasks are described in Table 2-1 under the "End Product/ Deliverable" column.

TABLE 2-1A

Project Tasks, Objectives, and Decision Processes – Develop Presumptive Remedy

Task/Activity	Purpose/Goal	End Product/Deliverable
.02 Develop Presumptive Remedy	**Develop a presumptive remedy for assessing cost/benefits of alternate approaches and to identify associated risks and unknowns. The presumptive remedy will be modified and updated as the project progresses.** **Existing Concept of Presumptive Remedy:** **Construct diversions for West Fork Milo Creek around Guy Caves, South Fork Milo Creek, and East Fork Milo Creek above South Fork Confluence.** **Use existing mine tunnels to collect and convey AMD to KT, pump from lower workings to keep water level at 11 level or below.** **Use lined pond for AMD storage but primarily use direct feed to CTP** **Update CTP using HDS technology, filtration, possibly iron co-precipitation. Replace neutralization/oxidation reactor, lime makeup and feed system, process control system. Update polymer system. Evaluate pumps, piping, and repair thickener. Add backup generator and critical spares. Update O&M manual.** **Place sludge in the mine in No. 3 Shaft or dry location if available. Also cost estimate mechanical dewatering and dry landfill as backup to in-mine disposal.**	**Complete presumptive remedy with: AMD generation mitigations, collection, conveyance, storage, treatment, and sludge disposal. The presumptive remedy will be defined and cost estimated as well as existing or readily available information permits.**
Identify, Size, and Cost Estimate AMD Generation Mitigation Measures	Develop presumptive AMD generation mitigations	List of AMD generation mitigations with estimate of cost and effectiveness for reducing strength and quantity of AMD requiring treatment.
Identify, Size, and Cost Estimate AMD Collection, Conveyance, and Storage Systems	Develop presumptive AMD collection, conveyance, and storage systems	List of AMD collection, conveyance, and storage system options, including cost estimates and list of data needs and risks.
Identify, Size, and Cost Estimate AMD Treatment System	Develop presumptive AMD treatment system	List of AMD treatment options for meeting the TMDLs, including cost estimates and list of data needs and risks.
Identify, Size, and Cost Estimate Sludge Disposal System	Develop presumptive sludge disposal system	List of sludge disposal options including cost estimates and list of data needs and risks.
Summarize Presumptive Remedy and ID Unknowns and Risks	Assemble the best presumptive remedy and tabulate and rank data needs and risks.	Assembled best currently known presumptive remedy and tabulate and rank data needs and risks.

TABLE 2-1B
Project Tasks, Objectives, and Decision Processes – Cost/Benefit Analysis

Task/Activity	Purpose/Goal	End Product/Deliverable
.03 Cost/Benefit Analysis	**Use existing or readily accessible information to evaluate the costs and benefits of AMD generation projects and alternate treatment systems. The presumptive remedy will be the baseline for cost estimating. Unknowns and data needs will be flushed out. The most cost effective and beneficial mitigations/treatment improvements will be carried forward for further scrutiny.**	**Ranked list of AMD mitigations and treatment improvements, using cost and effectiveness to reduce long-term AMD treatment costs as primary criteria. Also list of data gaps, unknowns, and risks to be addressed.**
Develop the Cost/Benefit Analysis Approach	Develop the approach to be used for cost/benefit analysis of AMD generation mitigations compared to treatment savings. A decision science tool may be useful.	Approach for cost/benefit analyses possible including a decision science tool.
Perform First Cut at Cost/Benefit Analysis	Perform the first cut at the cost/benefit analysis using presumptive remedy as base case.	First cut through analysis.
Redefine Data Needs and Define Approach to Obtain Data Needs	Restructure list of data needs, risks, and unknowns based on first cut through cost/benefit analysis. Summarize findings for stakeholder workshop.	Summary and presentation for workshop.
Stakeholder Workshop to Identify Needs and Concerns	Conduct a workshop with stakeholders to discuss findings to date, rank and prioritize data needs, and obtain consensus on path forward.	Workshop minutes with consensus.
Modify Cost/Benefit Analysis as More Data is Collected (On-Going)	Continue to use the cost/benefit analysis as the project progresses to help flush out details and focus effort on defining the long-term remedy.	Additional cost/benefit analyses as new is available.

TABLE 2-1C
Project Tasks, Objectives, and Decision Processes – Collect and Summarize Existing Information

Task/Activity	Purpose/Goal	End Product/Deliverable
.04 Collect and Summarize Existing Information	**Generate a working library of existing pertinent information to focus and streamline effort required for subsequent tasks.** **Existing Site Conditions:** **Considerable pertinent information available** **Not all available information known or readily accessible** **Available information not all assembled** **Emerging technologies may be applicable and more cost effective**	**Working project library and copy of library catalog distributed to all.**
Existing Documents Related to the Mine	Assemble existing mine information for use in subsequent tasks.	List of available documents and information with abstracts.
AMD Mitigation Technologies	Perform literature/agency/other search for AMD mitigation technologies and pertinent experience.	Summary of literature review documents with abstracts of the most promising.
AMD Treatment Technologies	Perform literature/agency/other search for AMD treatment technologies and pertinent experience.	Summary of literature review documents with abstracts of the most promising.
AMD/Sludge Reuse Technologies	Perform literature/agency/other search for AMD/Sludge reuse technologies and pertinent experience.	Summary of literature review documents with abstracts of the most promising.
In-Mine Sludge Disposal	Perform literature/agency/other search for in-mine sludge disposal technologies and pertinent experience.	Summary of literature review documents with abstracts of the most promising.
Develop Working Library	Assemble and catalog useful information.	Working project library and distributed library catalog.

TABLE 2-1D
Project Tasks, Objectives, and Decision Processes – New Data Collection and Develop Conceptual Model

Task/Activity	Purpose/Goal	End Product/Deliverable
.05 New Data Collection and Develop Conceptual Model	**Further the understanding of the hydrologic connection of the mine to surface features and surface and groundwater. Tool to help evaluate the potential effectiveness of AMD mitigation efforts, in-mine water storage, and sludge disposal.** **Existing Site Conditions:** **No recent data has been collected on AMD generation issues** **Bob Hopper has mentioned significant recent AMD flow/strength changes** **Preliminary AMD conceptual model prepared by Riley** **Current validity of Riley model unknown** **Key AMD producing areas and conduits must be updated/confirmed**	**Conceptual model, intended to be continuously updated as new information is developed.**
Develop Preliminary Conceptual Model	Using existing information develop a preliminary model to identify data gaps and to guide the development of the sampling and flow measurement program.	Preliminary conceptual model
Evaluate Structural Stability of the Mine	Determine the structural stability to ensure both short- and long-term safety as related to this work.	Technical memorandum which evaluates the structural stability of the mine for both short- and long-term safety needs as related to this work.
Design Sampling and Flow Measurement Program	To verify/update preliminary conceptual model.	Sampling and Analysis Plan QA/QC Plan
Implement Sampling and Flow Measurement Program	Implement the sampling and flow measurement program.	Field sampling report
Update/Modify Conceptual Model	Develop an updated model for subsequent project use.	Updated conceptual model, intended to be further updated as new information is developed.

TABLE 2-2
Data Needs and Uses

Parameter	Data Use	Data Users	Needed Detection Level
Lime Demand/Solids Formed	Assess strength of acid mine drainage (AMD) from different areas of the mine, and determine quantity of lime required to treat a unit volume, and the mass of sludge solids formed per unit volume.	Regulators, geochemists, hydrogeologists, and process engineers	2 lbs/1,000 gal
pH (Field)	Assess relative hydrogen ion concentration in AMD from different areas of the mine, and help evaluate pH process conrol needs for treatment plant.	Regulators, geochemists, hydrogeologists, and process engineers	0.1 pH units
Sulfate	Sulfate is the major anion in the AMD. The sulfate concentration will be proportional to the cations and will be used as an indicator of AMD strength from different areas of the mine. The sulfate concentration will also be used to assess potential for gypsum scaling of treatment equipment.	Regulators, geochemists, hydrogeologists, and process engineers	100 mg/L
EC (Field)	EC will be used to provide a relative comparison of AMD strength and also used for comparison to lime demand/solids formed. It may be possible to use EC as an indicator of lime demand/solids formed.	Regulators, geochemists, hydrogeologists, and process engineers	100 umho/cm
TSS	Assess the potential for solids loading to mine ditches, the lined AMD storgae pond, and the treatment plant.	Regulators, geochemists, hydrogeologists, and process engineers	10/mg/L
Total Fe, Zn, Cd, Pb, Mn, Mg	These are the major cations in the AMD. Zn, Pb, and Cd are the major metals of aquatic toxicity concern. These concentrations will be used to assess treatment requirements (pH, lime demand), and will be used to assess the highest acid and metal load sources in the mine.	Regulators, geochemists, hydrogeologists, and process engineers	0.1 mg/L (except magnesium 5 mg/L)
Dissolved Fe, Zn, Cd, Pb, Mn, Mg	The dissolved concentrations of metals will be compared to the total concentrations. Dissolved metal is of primary concern for aquatic toxicity. It is expected that the totals and dissolved concentrations will be similar except when there is high TSS. This data will help evaluate this assumption.	Regulators, geochemists, hydrogeologists, and process engineers	0.1 mg/L (except magnesium 5 mg/L)
Dissolved Ferrous Iron	Ferric iron is nearly insoluble at a pH of 4 to 4.5, ferrous at about pH 8. The proportion of ferric to ferrous is an important pH treatment system design parameter.	Regulators, geochemists, hydrogeologists, and process engineers	5 mg/L

Step 3: Identify Inputs to the Decision

The following inputs are necessary to assist in the decision points.

- Chemical inputs–Lime Demand/Solids Formed, pH, Sulfate, Conductivity (EC), Total Suspended Solids (TSS), Total Fe, Zn, Cd, Pb, Mn, Mg; Dissolved Fe, Zn, Cd, Pb, Mn, Mg; Dissolved Ferrous Iron.
- Physical inputs–Flow in gallons per minute.

The uses for the individual inputs are described in Table 2-2 and Table 2-1 under the "End Product/Deliverable" column.

Step 4: Define the Study Boundaries

The boundaries of the mine water study include the workings of the Bunker Hill Mine, the main mine entrance (Kellogg Tunnel), and the Milo Gulch Area. Flow measurement locations are presented in Table 3-1. Chemical and physical data will also be obtained from these locations.

Step 5: Develop a Decision Rule

Decision rules are described in Table 2-1 under the "End Product/Deliverable" column.

Step 6: Specify Tolerable Limits on Decision Factors

The sampling design, as described in Section 3, is based on comparability to past data, and a statistical design is not practicable. The mine water chemistry and flow rates are dynamic and change continuously, seasonally, and annually. Significant past characterization work has been conducted by the University of Idaho, but this data dates back 10 to 15 years. The mine water data collected in this study will be compared to that of past studies, and an effort will also be made to conduct a general water and metal balance around the mine workings, in that individual sources will be summed and compared to the discharge point (Kellogg Tunnel Flume) values. To achieve this, suitable tolerance limits for analytical measurements are plus or minus 25 percent, and suitable tolerance limits on flow measurement are plus or minus 10 percent.

Step 7: Optimize the Design

Sampling rationale and design are presented in Section 3.1.

Water samples will be collected on average bi-monthly from each sample location and analyzed for the parameters listed in Step 3. Flow rate measurements will be taken at time of sampling. Depending on results, sample collection frequency, locations, and types of analytical parameters may be adjusted as the project progresses to optimize data collection.

2.3.2 Data Users and Recipients

Data users include environmental scientists, soil scientists, regulators and community relations specialists. Data recipients include local government agencies, state regulatory agencies, or federal agencies, responsible parties and their consultants, various governmental or user group associations, and the community at large.

2.4 Data Quality Objectives and Criteria for Management Data (A7)

The quality assurance (QA) objective of this plan is to develop implementation procedures that will provide data of known and appropriate quality for the needs identified in Section 2.3. Data quality is assessed by representativeness, comparability, accuracy, precision, and completeness. Definitions of these terms, the applicable procedures, and level of effort are described below. The applicable QC procedures, quantitative target limits, and level of effort for assessing data quality are dictated by the intended use of the data and the nature of the analytical methods. Analytical parameters and applicable detection levels, analytical precision, accuracy, and completeness in alignment with needs identified in Section 2.3 are presented in Table 2-3.

TABLE 2-3
Data Quality Objectives

Parameter	Method	Target Detection Limit	Accuracy (% Recovery)	Precision (Relative % Deviation)	Completeness (%)
Total Metals					
Fe	CLP[a]	100 µg/L (CLP)[a]	75-125	±25	90
Zn	CLP[a]	20 L (CLP)[a]	75-125	±25	90
Cd	CLP[a]	5 µg/L (CLP)[a]	75-125	±25	90
Pb	CLP[a]	3 µg/L (CLP)[a]	75-125	±25	90
Mn	CLP[a]	15 µg/L (CLP)[a]	75-125	±25	90
Mg	CLP[a]	5000 µg/L (CLP)[a]	75-125	±25	90
Dissolved Metals					
Fe	CLP[a]	100 µg/L (CLP)[a]	75-125	±25	90
Zn	CLP[a]	20 L (CLP)[a]	75-125	±25	90
Cd	CLP[a]	5 µg/L (CLP)[a]	75-125	±25	90
Pb	CLP[a]	3 µg/L (CLP)[a]	75-125	±25	90
Mn	CLP[a]	15 µg/L (CLP)[a]	75-125	±25	90
Mg	CLP[a]	5000 µg/L (CLP)[a]	75-125	±25	90
Sulfate	EPA 300 or 375[b]	10 mg/L	75-125	±25	90
TSS[d]	EPA 160-2[b]	5 mg/L	75-125	±25	90
Lime Demand/ Solids Formed	[c]	2 lb/l000 gal	75-125	±25	90
Dissolved Ferrous Iron	[c]	2 mg/L	75-125	±25	90
pH	Field[e]	NA	NA	±0.1 pH units	90
EC	Field[e]	NA	NA	±100 µmho/cm	90

[a] EPA Contract Laboratory Program Statement of Work ILM 4.0.
[b] EPA 600/4-79-020 *Methods for Chemical Analysis of Water and Wastes*, revised March 1983.
[c] Procedures are provided in Appendix A.
[d] Total suspended solids
[e] Per field instrument manual procedure.
NA Not applicable

Detection limits shown in Table 2-3 meet the DQO requirements identified in Tables 2-1 and 2-2. However, actual laboratory reporting limits may be higher due to sample specific matrix interferences. The sample-specific detection limits will be reported for the individual analytes.

Representativeness is a measure of how closely the results reflect the actual concentration or distribution of the chemical compounds in the matrix samples. Sampling plan design, sampling techniques, and sample handling protocols (e.g., for storage, preservation, and transportation) have been developed and are discussed in subsequent sections of this document. The proposed documentation will establish that protocols have been followed and sample identification and integrity assured.

Comparability expresses the confidence with which one data set can be compared to another. Data comparability will be maintained using defined procedures and the use of consistent methods and consistent units. Actual detection limits will depend on the sample matrix and will be reported as defined for the specific samples.

Accuracy is an assessment of the closeness of the measured value to the true value. For samples, accuracy of chemical test results is assessed by spiking samples with known standards and establishing the average recovery. For a matrix spike, known amounts of a standard compound identical to the compounds being measured are added to the sample. A quantitative definition of average recovery accuracy is given in Section 5.3. Accuracy measurement will be carried out with a minimum frequency of 1 in 20 samples analyzed.

Precision of the data is a measure of the data spread when more than one measurement has been taken on the same sample. Precision can be expressed as the relative percent difference; a quantitative definition is given in Section 5.3. The level of effort for precision measurements will be a minimum of 1 in 20 samples.

Completeness is a measure of the amount of valid data obtained from the analytical measurement system and the complete implementation of defined field procedures. The quantitative definition of completeness is given in Section 5.3. The target completeness objective will be 90 percent; the actual completeness may vary depending on the intrinsic nature of the samples. The completeness of the data will be assessed during QC reviews.

2.5 Special Training Requirements/Certification (A8)

All project staff working on the site must be health and safety trained and must follow requirements specified in the project's Health and Safety Plan (HSP). The HSP describes the specialized training required for personnel on this project and the documentation and tracking of this training.

2.6 Documentation and Records (A9)

Laboratory data documentation will be per laboratory-specific standard operating procedures and methods/quality control procedures specified in Sections 3.4 and 3.5. Field documentation will be as described in Section 3.3. Overall project documentation will be per Arcs West Program quality assurance plan.

SECTION 3

Measurement/Data Acquisition

3.1 Sampling Process Design (B1)

Flow rate measurements and samples of the mine water will be collected from the locations shown in the attached Table 3-1. Each of these locations correspond to a location sampled by various University of Idaho researchers in the 1980's. These researchers performed a water and metal mass balance within the mine and determined which portions of the mine contribute water and metals. It is possible that significant changes have occurred in the mine and that the proportions of water and metal loads from different locations have changed from the 1980 measured values.

The purpose of this mine water flow rate and sampling effort is to produce data to conduct a new water and metal balance within the mine, and to compare the results to the 1980 results. This will help the understanding of the mine water dynamics with respect to time, and may help determine mitigation efforts to reduce the long-term water and metal load emanating from the mine requiring treatment.

3.2 Sampling Methods Requirements

Flow rate measurements will be collected at each sampling locations at the time of sampling. The following is a description of the procedures to be followed. The Field Sampling Plan (FSP) provides specific sampling and flow measurement details and will be consulted and adhered to.

1. Clean out the ditch both upstream and downstream of the flume a sufficient distance to obtain free, unobstructed flow through the flume. Ensure that there are no debris in the flume, particularly in the throat area and in the depth measurement locations.

2. Allow the flow to reestablish itself to steady-state conditions in the ditch and through the flume. If debris had caused a backup behind the flume, allow the backup to flush out. The goal is to only take a flow measurements and water samples when the flow through the ditch in the flume vicinity is unobstructed and representative of a clean drainage situation.

3. Measure the water depth at the two measurement locations in the flume. Record the depth to the nearest one-hundredth of a foot (0.01'). record these measurements into both the field notebook and onto the data sheets. Note any observations.

4. Collect a water sample by filling the sample containers from a location either directly upstream or downstream of the flume. Use a plastic bucket or pitcher to sample from the ditch. Rinse the bucket or pitcher thoroughly three times using ditch water, then scoop water from the ditch and pour it into the pre-labeled and pre-preserved sample containers. Follow the prescribed sampling, handling, documentation, and shipping requirements of the Field Sampling Plan (FSP).

Table 3-1
Mine Water Flow Measurement and Sample Collection Locations
Bunker Hill Mine Water Management

Location	Rationale	Maximum Measured Flows (Erikson, cfs)1	Maximum Measured Flows (Erikson, gpm)1	Measured Flow Dates (Erikson)	Maximum Measured Flows (Riley, gpm)2	Design Flows (gpm)3
Phase I Locations						
3 Level						
Utz Drift	Assess effectiveness of Milo Creek diversions					
Homestake Drift	Assess effectiveness of Milo Creek diversions					
5 Level						
Becker	Measure tributary flows from ore chutes. Discharges to the Loadout Area @ 9 Level.	0.29	130	2/83 to 9/84	113	228
Williams	Russell Tunnel, and various ore chutes and raises downstream from the New East Reed Flume. Discharge is tributary to the Loadout Area @ 9 Level.	0.42	188	2/83 to 9/84	192	336
West Reed	Flow originates from ore chutes, caved and flooded drifts west to the Cherry Raise area. Flow is normally tributary to the Becker Weir, occasionally tributary to the Reed Tunnel due to build-up downstream of the West Reed Flume.	0.046	21	2/84 to 9/84	29	51
9 Level						
Loadout Area @ 9 Level	Tributary to Kellogg Tunnel flume.	1.2	539	2/83 to 9/84	620	1085
Stanley Ore Chute	Drains a portion of the Guy Caving operation. Flow is tributary to the Loadout Area @ 9 Level.	0.025	11	2/83 to 9/84	11	20
Van Raise	Measures flow coming down the Cherry Raise from below the 5 Level. Tributary to the Loadout Area @ 9 Level.	0.067	30	12/83 to 9/84	33	58
No. 2 (White) Raise Pumps	Will be measured at the Kellogg Tunnel by taking the difference between flow while pumps are on versus flow while pumps are off.	NA	NA	NA	Approx. 550	NA
Kellogg Tunnel	Measures all discharge from the Bunker Hill Mine.	5.4	2424	1/83 to 8/84	2428	4249
Barney Switch	Measures drainage from the west end of the mine including areas around the No. 3, Orr, and Skookum Shafts. Tributary to Kellogg Tunnel Flume	0.85	381	12/83 to 9/84	253	668
Phase II Locations: Installed Only if Warranted by Phase I Data						
5 Level						
New East Reed Flume	Measure discharge from exploration drill holes, rock bolt holes, and fractures in the New East Reed Drift. The drainage area is isolated from overlying and underlying mine development. Flow is tibutary to Williams Weir. The need for this flume will be based on comparison of historic and current flows at Williams Weir.	0.11	49	1/84 to 9/84	69	121
Russel Dam Weir	Flow to this weir is controlled by low dam blocking the Old East Reed Drift. Discharge originates from drill holes and fractures in the Old East Reed Drift and from an ore chute in the Governor Cross-cut. Flow is tributary to the Williams Weir. The need for this flume will be based on comparison of historic and current flows at Williams Weir.	0.12	54	12/83 to 9/84	53	94
10 Level						
Deadwood Side, or Jersey	The need for this flume will be based on concentration and flow data obtained from No. 2 pump. Approximately 20 - 30 gpm coming from 10 level.					

Note: 1 - Based on maximum flows presented in *Analysis of Water Movement in An Underground Lead-Zinc Mine, Coeur d'Alene Mining District, Idaho*. D.L. Erikson, 1985.
2 - Based on maximum flows measured by Riley between 1/83 and 12/85.
3 - Based on the higher of Riley or Erikson maximum flows times 1.75 factor of safety.

3.3 Sample Handling and Custody Requirements

Procedures for sample handling, field documentation, and custody requirements, including field documentation (i.e., information to be included in field logbooks), sample identification, chain-of-custody procedures, packing, shipping and presentation, are detailed in the FSP. The following are the general requirements.

Sample Container Type, Preservation, and Holding Times

All samples will be packaged and preserved in accordance with requirements listed in Table 3-2.

TABLE 3-2
Sample Packaging and Preserving Requirements

Matrix	Analysis	Container Type	Preservation	Holding time
Water	Total metals Fe, Zn, Cd, Pb, Mn, Mg	1 liter polypropylene; Teflon-lined cap	pH <2 with HNO_3	6 months
Water	Dissolved metals Fe, Zn, Cd, Pb, Mn, Mg	1 liter polypropylene; Teflon-lined cap	Filter via 0.45 micron, pH <2 with HNO_3	6 months
Water	Sulfate	50 mL polypropylene[a] or glass	Cool, 4°C	28 days
Water	TSS	100 mL polypropylene[a] or glass	Cool, 4°C	7 days
Water	Lime demand/ solids formed	1 liter polypropylene	Cool, 4°C	NA
Water	Dissolved ferrous Iron	250 mL polypropylene, Teflon-lined cap	Filter via 0.45 micron, Cool, 4°C	48 hours

[a] If these analyses are being sent to the same laboratory, a 1 liter polypropylene bottle may be used for both.

Sample Custody and Documentation

Sample custody and documentation are vital aspects of a sampling event. Each sample must be properly documented to allow timely, correct, and complete analysis and to support use of the data. The documentation system provides the means to identify, track, and monitor each individual sample from the point of collection through final data reporting.

Field Custody and Documentation

The field personnel are responsible for the care and custody of the samples until the samples are delivered or dispatched to the laboratory. Field documentation procedures required for the collection and analysis of samples are detailed in the FSP. The Sample Documentation subsection describes the requirements for the following items:

- Sample Data and Chain-of-Custody Sheet
- As applicable, EPA Region 10 Analysis Request Forms
- As applicable, RAS Inorganic Traffic Report and Chain-of-Custody Records

- Sample Tags and Labels

Laboratory Custody and Documentation

Sample custody and documentation at the laboratories will conform to procedures established for the CLP (ILM 4.0) for metals and equivalent documentation for other analyses. At a minimum, the laboratory will follow the protocol listed below when accepting samples.

- A designated sample custodian accepts custody of the shipped samples and verifies that the samples received match those on the chain-of-custody records. Pertinent information as to shipment, pickup, and courier is entered in the Remarks section. The custodian then enters the sample numbers into a logbook.
- The laboratory custodian uses the sample identification label number or assigns a special laboratory number to each sample and is responsible for seeing that all samples are transferred to the proper analyst or stored in the appropriate secure area.
- The custodian distributes samples to the appropriate analysts. Laboratory personnel are responsible for the care and custody of samples from the time they are received until the sample is exhausted or returned to the custodian. The date of sample analyses is recorded on the laboratory report form.

When sample analyses and necessary QA checks have been completed in the laboratory, the unused portion of the sample must be disposed of properly. All identifying stickers, data sheets, and laboratory records are retained as part of the permanent documentation. Sample containers and remaining sample materials are disposed of appropriately.

Corrections to Documentation

Unless prohibited by weather conditions, all entries into field and laboratory notebooks will be written with waterproof ink. No accountable serialized documents are to be destroyed or thrown away, even if they are illegible or contain inaccuracies that require a replacement document. If an error is made on an accountable document assigned to one person, that person shall make corrections by drawing a line through the error and entering the correct information. The erroneous information should remain legible. Any subsequent error discovered on an accountable document should be corrected by the person who made the entry. All corrections must be initialed and dated.

Document Control

Document control procedures will be used during the collection and analysis of samples so that documents for each sample will be accounted for when the project is completed. Written explanations must be prepared for any unaccounted for documents.

Once sampling has been completed, the files containing the data and all supporting information will be assembled, organized, and securely stored.

3.4 Analytical Methods Requirements

Analytical parameters and methods are listed in Table 2-3. Metals will be analyzed per EPA CLP ILM4.0. Sulfate and total suspended solids will be analyzed per standard EPA methods listed in Table 2-3. Project specific procedures for Lime Demand/Solids Formed and Ferrous Iron are provided in Appendix A.

3.5 Quality Control Requirements

Field Quality Control Procedures

Field duplicates, quality control samples, blanks, and equipment rinsates are described in the field sampling plan. These field quality control samples will be collected at a minimum frequency of 5 percent.

Laboratory Quality Control Procedures

Metals analyses will be subject to the following:

- Methodology as specified in Section 3.4
- Calibrations and internal QC checks per CLP-SOW ILM 4.0 as shown in Section 3.7
- Accuracy and precision criteria per CLP-SOW ILM 4.0
- Blanks per CLP-SOW ILM 4.0
- Documentation per CLP-SOW ILM 4.0

Analyses other than metals will be subject to method (specified in Section 3.4) quality control requirements and the following minimum quality control requirements, as applicable:

- Minimum five-point initial calibration—subject to relative standard deviation or coefficient of variation criteria
- Daily continuing calibrations—subject to relative percent difference or deviation criteria
- Daily laboratory control standards measurements—subject to laboratory-specific limits not to exceed recovery limits of 75 to 125 percent
- Accuracy and precision measurements at a frequency of 5 percent
- Blank measurement at a frequency of 5 percent
- Documentation equivalent to EPA CLP documentation.

3.6 Instrument/Equipment Testing, Inspection, and Maintenance Requirements

Field Equipment

Field equipment, will be inspected and maintained by CH2M HILL (contractor) on a routine basis. Prior to using any instrument in the field, it will be calibrated in accordance with the manufacturer's instructions and field-tested. If applicable records of inspection, calibration and field testing will be maintained in the daily field diary.

Analytical Laboratory Equipment

Laboratory analysis equipment is routinely tested, inspected, and maintained in accordance with the laboratory-specific QA/QC manual and the manufacturer's requirements. Records of equipment maintenance, calibration and testing are maintained by the laboratory.

3.7 Instrument Calibration and Frequency

All field instruments and equipment used during this project will be operated, calibrated, and maintained according to the manufacturers' guidelines and recommendations. Operation, calibration, and maintenance will be performed by personnel who have been properly trained in these procedures. A routine schedule and record of instrument calibration and maintenance will be maintained throughout the duration of this project.

Calibration of laboratory owned and operated equipment will be in accordance with the laboratory quality assurance/quality control plan, the methods and the quality control specified in Sections 3.4 and 3.5.

3.8 Inspection/Acceptance Requirements for Supplies and Consumables

Supplies and consumables anticipated for use at the site primarily include sample containers, decontamination fluids, acetate liners (soil and sediment), and personal protection equipment. Consumables will be purchased in original packaging and stored in a manner that protects their usability. If long-term storage of consumables is necessary, they will be inspected prior to their use to detect any damage or disintegration of the material.

3.9 Data Acquisition Requirements (Non-Direct Measurements)

Past data to be used for this study will be derived mainly from University of Idaho publications in hard copy form. This past data may be entered into an electronic spreadsheet and/or database that will be subject to the data management practices described below. Laboratory hard copy deliverables will be per specification in Section 2.0 and Section 3.5.

3.10 Data Management

Data management can be defined as comprising the functions of creating and accessing stored data, enforcing data storage conventions, and regulating data input and output. The stored data will include parameters measured in soils at the site.

For this project, data management will involve the use of a computerized data management system. The system will provide a centralized, secure location for data of known quality that can be shared and used for multiple purposes. The data management system will assist in the information flow for the project by providing a means of cataloging, organizing, archiving, and accessing information.

The data management system will include three main elements:

The database: An organized and structured storehouse of data used for multiple purposes. Initially a spreadsheet program will be used, and if justified by project needs, a relational database will be used later.

Data management procedures: The steps involved in the data management process

Personnel: The project staff who develop, implement, and administer the database and procedures

These elements are briefly described in the following subsections.

The Database

A spreadsheet will be created to store data collected as part of this effort. The software being used in support of the spreadsheet is Microsoft Excel. If justified by project needs, Microsoft Access will be the relational database.

Data Management Procedures

Data management procedures are a crucial part of the data management system. Established procedures are necessary to ensure consistency among data sets, internal database integrity, and a verified, usable data set. The tasks and procedures that will be performed for all project data before they are entered include:

- **Data mapping.** The process by which the collected environmental data are selected, marked, and corrected named for entry into the database.
- **Electronic data interchange.** To facilitate data interchange between the analytical laboratory and the data user. Detailed specifications will be developed for both receipt and delivery of electronic data including data importing and data exporting.
- **Data entry and verification.** The process by which data are correctly entered into the database including data preparation, data import and entry, and data verification.
- **Data presentation and analysis.** Data from the database may be presented in two types of reports: (1) Appendix-style reports which (tabular listings sorted by station and sample ID) and (2) Summary statistics (frequency of detection, mean, minimum values, maximum values, standard deviation, and variance) sorted by station, depth and parameter.
- **Data administration.** Effective administration of the data management system will reduce the likelihood of errors and ensure the integrity of the database. Data administration tasks include data redundancy control, operation and maintenance of the database, documentation of the data management process, and closing out the data management task in both interim and final stages of completion.

Personnel

Successful implementation of a data management system requires a clear definition of responsibilities. The data management system will be carried out by the project data coordinator and a database technician. The project data coordinator has an overall view of the project. Responsibilities includes database integrity, redundancy control, data sharing and version control, performance, security, and backup. The database technician has a comprehensive understanding of the database structure, software, and associated analysis tools. Responsibilities include data logging and tracking, data preparation, data entry and verification, data archiving, data requests, and report generation.

SECTION 4

Data Assessment and Response Actions

4.1 Data Assessments

The system audit is a systematic check of a qualitative nature consisting of an onsite review of a laboratory's quality assurance system and physical facilities for sampling, calibration, and measurement. System audits for this project will be performed on an as-needed basis.

Performance audits provide a systematic check of laboratory operations and measurement systems by comparing independently obtained data with routinely obtained data. Performance audits will be scheduled on an as-needed basis.

4.2 Reports to Management–Response Actions

If the quality control audit results in detection of unacceptable conditions or data, the SM will be responsible for developing and initiating corrective action. Onsite staff will be notified if the nonconformance relates to their work. Corrective action may include:

- Reanalyzing the samples
- Resampling and analyzing
- Evaluating and amending sampling and analytical procedures
- Accepting data, acknowledging level of uncertainty or inaccuracy by flagging the data

SECTION 5

Data Validation and Usability

5.1 Data Review, Validation, and Verification Requirements (D1)

All data for all parameters will undergo two levels of review and validation: (1) at the laboratory and (2) outside the laboratory by the EPA Quality Assurance Management Section or their designee.

5.2 Validation and Verification Methods (D2)

Initial data reduction, validation, and reporting at the laboratory will be carried out as described in the laboratory standard operating procedures.

Independent data validation by EPA or their designee will follow EPA Contract Laboratory Program National Guidelines for Inorganic Data Review, February 1994.

5.3 Reconciliation with Data Quality Objectives (D3)

Assessment of data for precision, accuracy, and completeness will be per the following quantitative definitions.

Precision

If calculated from duplicate measurements:

$$RPD = \frac{(C_1 - C_2) \text{ x } 100\%}{(C_1 + C_2) / 2}$$

RPD = relative percent difference
C_1 = larger of the two observed values
C_2 = larger of the two observed values

If calculated from three or more replicates, use relative standard (RSD) rather than RPD:

$$RSD = (s / \bar{y}) \text{ x } 100\%$$

RPD = relative standard deviation
s = standard deviation
$\bar{y}$ = mean of replicate analyses

Standard deviation, s, is defined as follows:

$$S = \sqrt{\sum_{i=1}^{n} \frac{(yi/y)^{-2}}{n-1}}$$

s = standard deviation
y_i = measured value of the i^{th} replicate
$\bar{y}$ = mean of replicate analyses
n = number of replicates

Accuracy

For measurements where matrix spikes are used:

$$\%R = 100\% \times \left[\frac{S-U}{C_{sa}}\right]$$

%R = percent recovery
S = measured concentration in spiked aliquot
U = measured concentration in unspiked aliquot
C_{sa} = actual concentration of spike added

For situations where a standard reference material (SRM) is used instead of or in addition to matrix spikes:

$$\%R = 100\% \times \left[\frac{C_m}{C_{sm}}\right]$$

%R = percent recovery
C_m = measured concentration of SRM
C_{sm} = actual concentration of SRM

Completeness (Statistical)

Defined as follows for all measurements:

$$\%C = 100\% \times \left[\frac{V}{T}\right]$$

%C = percent completeness
V = number of measurements judged valid
T = total number of measurements

References

U.S. Environmental Protection Agency. *EPA Guidance for Quality Assurance Project Plans,* EPA QA/G5, EPA/600/R-98/018, February, 1998

U.S. Environmental Protection Agency. *Guidance for the Data Quality Objectives Process,* EPA QA/G4, September 1994.

U.S. Environmental Protection Agency. *Contract Laboratory Program National Functional Guidelines for Inorganic Data Review,* February 1994.

Appendix A

Nonstandard Analytical Procedures

Lime Demand & Solids Formed Test for Low Strength AMD (pH>2)

1. Measure 250 mL AMD in a volumetric flask. Transfer the AMD into a 500 mL beaker. Place the beaker under a high shear prop type mixer and turn on the mixer. Adjust the mixer speed to ensure high shear, well agitated mixing.
2. Calibrate a 200 mL volume mark on a 500 mL beaker. In the 500 mL beaker add 2.0 grams of Calcium Hydroxide. Carefully add water until it is to the 200 mL mark on the beaker. Place a magnetic stir bar in the lime slurry beaker and use a magnetic mixer to mix the lime during the test. Adjust the magnetic mixer speed to ensure no settling of the lime and to ensure well mixed conditions in the beaker.
3. Add lime slurry to the AMD in 10 mL increments and wait for the pH to stabilize between additions. Record the stabilized pH between additions and the lime slurry added in each addition. At a pH of about 8.5, switch to adding lime slurry in 1.0 mL increments and continue to record the pH between additions. Continue until the pH reaches 10.
4. Weigh and record the weight of a new 70 mm Whatman 934-AH glass fiber filter and a clean aluminum drying pan (about 5" diameter). This is the "TARE WEIGHT".
5. Place the filter into a 70 mm Buchner filter apparatus attached to a vacuum source and moisten the filter with DI water. Turn on the vacuum source.
6. Tare the 500 mL beaker containing the pH 10 slurry on a top loading scale. The scale will read 0.0 gm.
7. Slowly pour the entire contents into the 70 mm Buchner filter apparatus. Use DI water to wash any remaining solids out of the beaker and into the filter. Maintain a vacuum of between 15 and 20 in Hg.
8. Continue filtering until the liquid leaves the surface of the sludge and then filter for 90 seconds more and then turn off the vacuum.
9. Place the beaker back on the scale and record the weight of slurry that was poured into the filter. This weight will be displayed as a negative weight on the scale. This is the "SLURRY WEIGHT".
10. Remove the filter cake and filter paper from the filter and place them into the aluminum drying pan. One technique to remove the cake is to quickly invert and "slam" the Buchner filter apparatus onto the aluminum drying pan. Another technique is to use air to blow the cake out of the filter and onto the pan. Use a scraper to scrape any remaining solids from the filter and into the pan.

11. Dry the filter cake and filter paper overnight to a constant weight at 103 to 105 degrees C.

12. Cool and weigh. Record the weight. This is the "FINAL WEIGHT".

13. Subtract the "TARE WEIGHT" from the "FINAL WEIGHT". This is the "DRIED WEIGHT" (grams).

FORMULAS:

Lime Demand (lbs lime/1,000 gal AMD) = mLs lime added x 0.04 x 8.345

Solids Formed (lbs solids/1,000 gal AMD) = "DRIED WEIGHT" (grams) x 33.35

Approved:______________________ Date:______________________

Determination of Ferrous Iron by Titration with Dichromate

Discussion: This method can be used to determine the ferrous iron concentration in acidic wastewater samples.

Apparatus:

Drying oven	Syringes:
Analytical balance	20 ml, plastic, 2
Beakers, 250 mo, 2	10 ml, glass, 2
Ring Stand assembly	10 ml, plastic, 2
Magnetic stir plate	Stir bars, 1-inch, 2
Buret holder	Wash bottle
Eyedropper, 2	Buret, 25 ml

Reagents:

Distilled water

0.1N Potassium dichromate

Add 4.903 grams of dried, desiccated, primary standard grade potassium dichromate to 800 mls of distilled water. Dissolve and dilute to exactly 1.0 liter in a volumetric flask. (If primary standard grade potassium dichromate is not available, standardize the dichromate solution against a primary standard iron solution.)

Iron indicator

Add 0.2 grams sodium diphenylamine sulfonate to 100 mls of distilled water.

Concentrated hydrochloric acid

Concentrated sulfuric acid

Concentrated phosphoric acid

Procedure:

1. To an appropriate weight of sample, add:
   - 10 mls concentrated hydrochloric acid
   - 10 mls concentrated sulfuric acid
   - 15 mls concentrated phosphoric acid
   - 8 drops iron indicator

2. Dilute the volume to approximately 100 mls.

3. Titrate with 0.1N potassium dichromate solution to a violet end point.

Calculation:

Ferrous Iron, ppm =

$$\frac{(\text{mls titrant})*(\text{Normality of titrant})*(55,850)}{(\text{mls sample})}$$